

CLAIMS

What is claimed is:

1. A catalyst for use in oxidation or reduction reactions, the catalyst comprising platinum at a concentration that is no greater than 60 atomic percent, titanium, and tungsten.
2. A catalyst for use in oxidation or reduction reactions, the catalyst comprising platinum, titanium at a concentration of at least 20 atomic percent, and tungsten.
3. A catalyst for use in oxidation or reduction reactions, the catalyst comprising platinum, titanium, and tungsten, wherein the concentration of tungsten is at least 25 atomic percent.
4. The catalyst of any one of claims 1-3 wherein the concentration of platinum is no greater than about 50 atomic percent.
5. The catalyst of any one of claims 1-4 wherein titanium is at a concentration that is no greater than about 80 atomic percent.
6. The catalyst of any one of claims 1-5 wherein tungsten is at a concentration that is no greater than about 80 atomic percent.
7. The catalyst of any one of claims 1, 2, 5 or 6 wherein platinum is at a concentration between about 5 and 60 atomic percent, titanium is at a concentration that is no greater than about 80 atomic percent, and tungsten is at a concentration that is between about 10 and about 80 atomic percent.
8. The catalyst of any one of claims 1, 4, 5 or 6 wherein platinum is at a concentration that is between about 10 and about 50 atomic percent, titanium is at a concentration that is between about 1 and about 55 atomic percent, and

tungsten is at a concentration that is between about 20 and about 60 atomic percent.

9. The catalyst of any one of claims 1, 3, 4, 5 or 6 wherein platinum is at a concentration that is between about 20 and about 45 atomic percent, titanium is at a concentration that is between about 5 and about 40 atomic percent, and tungsten is at a concentration that is between about 30 and about 55 atomic
5 percent.

10. The catalyst of any one of claims 1, 3, 4, 5 or 6 wherein platinum is at a concentration that is between about 30 and about 50 atomic percent, titanium is at a concentration that is no greater than about 20 atomic percent, and tungsten is at a concentration that is between about 40 and about 60 atomic
5 percent.

11. The catalyst of any one of claims 1, 3, 4, 5 or 6 wherein platinum is at a concentration that is between about 35 and about 45 atomic percent, titanium is at a concentration that is between about 5 and about 15 atomic percent, and tungsten is at a concentration that is between about 45 and about 55 atomic
5 percent.

12. The catalyst of any one of claims 1, 2, 3, 4, 5 or 6 wherein platinum is at a concentration that is between about 20 and about 40 atomic percent, titanium is at a concentration that is between about 25 and about 45 atomic percent, and tungsten is at a concentration that is between about 30 and about
5 50 atomic percent.

13. The catalyst of any one of claims 1, 2, 3, 4, 5 or 6 wherein platinum is at a concentration that is between about 25 and about 35 atomic percent, titanium is at a concentration that is between about 30 and about 40 atomic percent, and tungsten is at a concentration that is between about 35 and about
5 45 atomic percent.

14. The catalyst of any one of claims 1, 2, 4, 5 or 6 wherein platinum is at a concentration between about 10 and about 50 atomic percent, titanium is at a concentration between about 30 and about 80 atomic percent, and tungsten is at a concentration of less than about 25 atomic percent.

15. The catalyst of any one of claims 1, 2, 4, 5 or 6 wherein platinum is at a concentration between about 15 and about 45 atomic percent, titanium is at a concentration between about 40 and about 75 atomic percent, and tungsten is at a concentration between about 5 and about 20 atomic percent.

16. The catalyst of any one of claims 1, 2, 4, 5 or 6 wherein platinum is at a concentration between about 20 and about 40 atomic percent, titanium is at a concentration between about 50 and about 65 atomic percent, and tungsten is at a concentration of between about 5 and about 15 atomic percent.

17. A catalyst for use in oxidation or reduction reactions, the catalyst comprising platinum, titanium at a concentration that is between about 2 and about 12 atomic percent, and tungsten.

18. A catalyst for use in oxidation or reduction reactions, the catalyst comprising platinum, titanium, and tungsten at a concentration that is between about 2 and about 12 atomic percent.

19. The catalyst of claim 17 or 18 comprising platinum at a concentration that is between about 70 and about 85 atomic percent.

20. The catalyst of any one of claims 1-19 consisting essentially of platinum, titanium and tungsten.

21. The catalyst of any one of claims 1-19 wherein the catalyst comprises an alloy of platinum, titanium and tungsten.

22. The catalyst of any one of claims 1-19 wherein the catalyst consists essentially of an alloy of platinum, titanium and tungsten.

23. A supported electrocatalyst powder for use in electrochemical reactor devices, the supported electrocatalyst powder comprising the catalyst of one of claims 1-22 and electrically conductive support particles upon which the catalyst is dispersed.

24. The supported electrocatalyst powder of claim 23 wherein the electrically conductive support particles are selected from the group consisting of carbon supports and electrically conductive polymer supports.

25. A fuel cell electrode, the fuel cell electrode comprising electrocatalyst particles and an electrode substrate upon which the electrocatalyst particles are deposited, the electrocatalyst particles comprising the catalyst as in any one of claims 1-22.

26. The fuel cell electrode of claim 25 wherein the electrocatalyst particles comprise electrically conductive support particles upon which the catalyst is dispersed.

27. The fuel cell electrode of claim 26 wherein the electrically conductive support particles are selected from the group consisting of carbon supports and electrically conductive polymer supports.

28. A fuel cell comprising an anode, a cathode, a proton exchange membrane between the anode and the cathode, and the catalyst as in any one of claims 1-22 for the catalytic oxidation of a hydrogen-containing fuel or the catalytic reduction of oxygen.

29. The fuel cell of claim 28 wherein the fuel consists essentially of hydrogen.

30. The fuel cell of claim 28 wherein the fuel is a hydrocarbon-based fuel.
31. The fuel cell of claim 28 wherein the fuel comprises methanol.
32. The fuel cell of claim 28 wherein the catalyst is on the surface of the proton exchange membrane and in contact with the anode.
33. The fuel cell of claim 28 wherein the catalyst is on the surface of the anode and in contact with the proton exchange membrane.
34. The fuel cell of claim 28 wherein the catalyst is on the surface of the proton exchange membrane and in contact with the cathode.
35. The fuel cell of claim 28 wherein the catalyst is on the surface of the cathode and in contact with the proton exchange membrane.
36. A method for the electrochemical conversion of a hydrogen-containing fuel and oxygen to reaction products and electricity in a fuel cell comprising an anode, a cathode, a proton exchange membrane therebetween, the catalyst as in any one of claims 1-22, and an electrically
5 conductive external circuit connecting the anode and cathode, the method comprising contacting the hydrogen-containing fuel or the oxygen and the catalyst to catalytically oxidize the hydrogen-containing fuel or catalytically reduce the oxygen.
37. The method of claim 36 wherein the hydrogen-containing fuel consists essentially of hydrogen.
38. The method of claim 36 wherein the hydrogen-containing fuel is a hydrocarbon-based fuel selected from the group consisting of saturated hydrocarbons, garbage off-gas, oxygenated hydrocarbons, fossil fuels, and mixtures thereof.

39. The method of claim 36 wherein the hydrogen-containing fuel is methanol.

40. A fuel cell electrolyte membrane having an unsupported catalyst layer on a surface thereof, said unsupported catalyst layer comprising the catalyst of any one of claims 1-22.

41. A fuel cell electrode having an unsupported catalyst layer on a surface thereof, said unsupported catalyst layer comprising the catalyst of any one of claims 1-22.